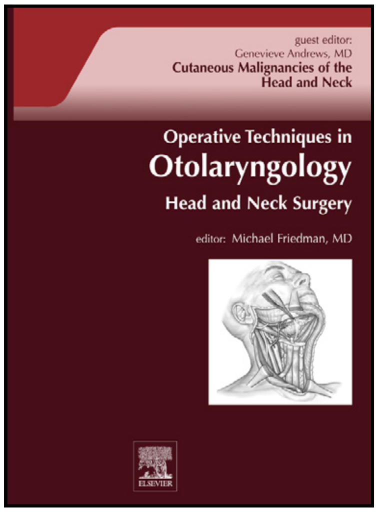




# Lingual tonsillectomy and midline posterior glossectomy in children with Obstructive Sleep Apnea

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**Title:**
Lingual tonsillectomy and midline posterior glossectomy in children with Obstructive Sleep Apnea

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**ABSTRACT**

Lingual tonsillectomy and midline posterior glossectomy are useful in children with persistent obstructive sleep apnea following tonsillectomy and adenoidectomy who do not tolerate positive airway pressure ventilation. These techniques involve removing tissue from the surface (lingual tonsil) or base (midline posterior glossectomy) of the tongue to decrease bulk in the oropharynx. The aim of this review is to delineate the preoperative evaluation and intraoperative considerations of lingual tonsillectomy and midline posterior glossectomy in children.

## INTRODUCTION

Tonsillectomy and adenoidectomy (TA) successfully treats obstructive sleep apnea (OSA) in approximately 75% of children.[1,2] Unfortunately, this rate is much lower (25% - 45%) in children who are obese, older than seven years of age, have asthma, more severe sleep apnea, craniofacial anomalies, and chromosomal abnormalities such as Down syndrome.[2-5] Persistent OSA following TA, however, is difficult to investigate and treat. Long term adherence to positive airway pressure (PAP; continuous (CPAP) or bilevel (BIPAP)) ventilation in children, especially those who are syndromic, is poor.[6] Uvulopalatopharyngoplasty alone has not proven to be successful in children.[7] Tracheotomy, which has historically been the gold standard treatment for persistent severe OSA following TA, carries the inherent risks of mucous plugging, accidental decannulation, bleeding and poor quality of life for patients and their families, making it an operation of last resort.

Recently, a few otolaryngologists – head and neck surgeons have begun tailoring surgery for each patient with OSA by searching for anatomically abnormal areas that would most likely be the cause of their obstruction. This usually takes the form of sleep endoscopy or sleep/CINE magnetic resonance imaging (MRI). Examples of anatomical sources of obstruction that have been targeted include lingual tonsil hypertrophy, macroglossia (large tongue), and glossoptosis (posterior prolapse of the tongue).[8,9] Shott (2011) has published a detailed review on the evaluation and management of pediatric obstructive sleep apnea beyond tonsillectomy and adenoidectomy.

## PREOPERATIVE PLANNING

Patients who have already undergone TA, continue to have severe OSA, and cannot tolerate PAP ventilation are candidates for further surgery at our institution. A full history and physical examination is performed.

### Physical examination

Generally inspect for syndromic features that could contribute to airway narrowing such as midface hypoplasia, steep mandibular plane (obtuse gonial angle), long facial height (adenoid facies), and retrognathia. Inspect the nose for a deviated septum, large inferior turbinates, pyriform aperture stenosis, nasal polyps, cysts, tumors or choanal atresia. Inspect the mouth for retrognathia, macroglossia, narrow high-arched palate and dental wear secondary to bruxism. Flexible nasopharyngoscopy can detect adenoid regrowth, nasopharyngeal cysts and tumors, lateral pharyngeal wall collapse, lingual tonsil hypertrophy, glossoptosis, abnormalities in the shape and position of the epiglottis, arytenoid edema due to acid reflux and impaired vocal cord movement. Sleep endoscopy under general anesthesia can be performed to better identify areas of collapse during relaxation. However, care must be taken not to overestimate the degree of collapse under general anesthetic due to muscle relaxation induced by the agent itself.[7] Anecdotal evidence suggests that alternatives such as dexmedetomidine (alpha 2 agonist that parallels nonrapid-eye-movement sleep without significant respiratory depression) may cause less airway collapse than propofol, however, this has not been demonstrated using upper airway measurements on CINE MRI.[7,10,11]

### Imaging

Lateral neck x ray can detect adenoid regrowth and lingual tonsil hypertrophy, but carries the risks of radiation and overestimation of adenoid size if the patient is swallowing and the soft palate is in contact with the adenoid tissue. For these reasons, this author prefers flexible nasopharyngoscopy over lateral neck x ray for evaluation of adenoid and lingual tonsil tissue. CINE MRI allows for analysis of the airway during episodes of airway obstruction. Donnelly (2005) has described in detail how to perform and interpret CINE MRI studies in children with OSA.[12] In brief, multiple anatomical sites can be examined on mid-sagittal and axial sections simultaneously. T2-weighted images are helpful for identifying the adenoids and differentiating lingual tonsil tissue from the base of tongue. Adenoids are considered large if they are thicker than 12 mm on sagittal section with intermittent obstruction of the posterior nasopharynx. Lingual tonsils are considered large if they are thicker than 10 mm and abut both the tongue and the posterior pharyngeal wall.[12] An added benefit of CINE MRI over sleep endoscopy is that CINE MRI can detect a Chiari malformation. Chiari malformations involve herniation of the cerebellar tonsils with or without the brainstem into the foramen magnum and/or spinal cord which can cause obstructive and/or central sleep apnea.[13] CINE CT has been described but is not recommended due to high levels of ionizing radiation.

## LINGUAL TONSILLECTOMY

### Rationale

Lingual tonsil hypertrophy has been described as a cause of persistent OSA following TA.[8] Approximately 54% of patients with lingual tonsil hypertrophy as a cause of persistent OSA have another disorder such as Down syndrome, Beckwith-Wiedemann

syndrome, or velocardiofacial syndrome.[8] Approximately 30% of patients with Down syndrome who have persistent OSA following TA have enlarged lingual tonsils.[9] Lin and Koltai (2009) first described lingual tonsillectomy for persistent pediatric OSA and demonstrated significant reductions in respiratory disturbance index (RDI) and mean number of apneas per hour following this procedure. The surgical technique described below builds on previous authors' descriptions and adds this author's personal preferences.

**Patient Positioning**

Patient positioning is demonstrated in Figure 1. The patient is nasotracheally intubated through the left nasal cavity and the endotracheal tube (ETT) is taped to a square piece of foam padding that is taped to the forehead. The eyes are taped shut for protection but are left undraped. A shoulder roll is not used because many of these children have Down syndrome and neck extension can lead to atlantoaxial subluxation. This can occur even if preoperative flexion-extension x rays are normal, rendering preoperative acquisition of such x rays unnecessary.[14]

**The Procedure**

A tooth guard is trimmed to fit the patient's mouth and a 2-0 silk suture is placed through the anterior aspect of the tongue in the midline for retraction (Figure 2). The surgeon stands at the head of the bed. An age-appropriate Benjamin laryngoscope (infant, child or adult) with the light cable down the left side of the scope works well to hold the soft tissues of the mouth open to provide good visualization (Figure 3). The silk suture retracting the tongue anteriorly can be wrapped around the hook on the handle of the

laryngoscope to obviate the need for an assistant retracting the tongue for the duration of the case. Although many devices can be used to remove lingual tonsil tissue, the Coblator wand (EVac 70 Xtra Plasma Wand; ArthroCare ENT, Austin, TX) is easy to use and surprisingly does not produce much postoperative edema or pain. The Coblator is placed down the right side of the mouth outside of the laryngoscope to provide optimal visualization and range of motion (Figure 4). The procedure can be performed under direct visualization with or without magnifying loupes, or through a 0 degree x 4 mm x 30 cm telescope placed down the left side of the laryngoscope by an assistant with the video screen at the foot of the bed.

It is imperative that the surgeon visualizes the epiglottis throughout the entire procedure. Elevating the laryngoscope toward the ceiling exposes the uvula, ETT, epiglottis and lingual tonsil (Figure 5). Coblator settings of 7 (ablate) and 3 (coagulate) work well for this procedure. Adequate irrigation is essential when using the Coblator, and a pressure bag for the saline may be required. Place the Coblator in a bowl of saline and let it ablate for approximately ten seconds prior to first use. Gently glide back and forth over the lingual tonsil tissue using light pressure until the tissue evaporates (Figure 6). Avoid touching the epiglottis, even though minor contact does not seem to cause edema. Ablation in hidden crevices may lead to bleeding that can be difficult to control. Bleeding should be stopped by pressing the Coblator wand firmly on the bleeding area and using the coagulation setting for five seconds. If this does not work after two or three attempts, a suction monopolar cautery may be employed for hemostasis. The patient is extubated in the operating room. A nasal trumpet may be required.

**Postoperative Care**

This author gives clindamycin for ten days to prevent infection from oral anaerobes. Steroids may be given if lingual tonsillectomy is not being performed concurrently with midline posterior glossectomy. Patients are observed in a closely monitored bed overnight and are discharged when they are eating well, afebrile and their pain is controlled. Repeat polysomnography is performed six months postoperatively. PAP ventilation may be applied if necessary as long as maximum levels of humidity are used.

**Special Considerations**

If revision adenoidectomy is also required, the nasotracheal tube can be pushed from side to side with a dental mirror to first remove one half, and then the other half, of the adenoids. Alternatively, if this is too difficult to perform, the nasotracheal tube can be converted to an oral tube (preferably before but may be after lingual tonsillectomy) and the adenoids can be removed in standard fasion.

**MIDLINE POSTERIOR GLOSSECTOMY**

**Rationale**

Macroglossia and glossoptosis have been described as causes of persistent OSA following TA.[9] Approximately 74% of patients with Down syndrome who have persistent OSA following TA have macroglossia and 63% have glossoptosis.[9] Maturo and Mair in 2006 described the submucosal minimally invasive lingual excision (SMILE) procedure in children as the first intraoral approach to tongue base reduction using Coblation under ultrasound guidance[15]. Their technique involves placing the Coblator through an anterior tongue incision and sequentially removing tissue until the posterior

tongue is reached. Shott revised this surgery to directly visualize and ablate the posterior tongue base.[16] Clark demonstrated a success rate of 59% (defined as postoperative AHI less than 5, no hypercarbia and no hypoxemia less than 90%) following midline posterior glossectomy in children with Down syndrome and persistent OSA following TA[16]. Wootten and Shott demonstrated a similar success rate (61%) using the Repose (Medtronic, Minneapolis, MN) genioglossus advancement with a higher success rate in children without Down syndrome (66%) than with Down syndrome (58%)[17]. Because both the midline posterior glossectomy and the Repose genioglossus advancement have relatively the same success rate treating macroglossia/glossoptosis, and because the midline posterior glossectomy would necessitate removing any previously placed Repose sutures thus negating the benefits of the Repose, midline posterior glossectomy is recommended as the procedure of first choice (personal communication from Sally Shott). If success is not obtained, a subsequent Repose genioglossus advancement can be performed and the patient can benefit from both procedures.

**Patient Positioning**

The patient is usually already nasally intubated through the left nasal cavity because a prior lingual tonsillectomy is almost always necessary to access the tongue base. Patient positioning is the same as for lingual tonsillectomy but the tooth guard is removed. However, the surgeon stands on the right side of the patient for this procedure and wears a headlight.

**The Procedure**

An age-appropriate wedge-shaped dental bite block is placed in the left side of the mouth and an age-appropriate dental cheek and lip retractor are used (Figure 7). The tongue is

retracted anteriorly while the lingual arteries are identified using ultrasound (Figure 8). The L-shaped “hockey stick” ultrasound probe commonly used by anesthesiologists to guide vascular access procedures works well for this. Make sure that plenty of gel with a minimal amount of air bubbles surrounds the probe and place an elastic band around the shaft of the probe to keep the gel in place. Place the probe horizontally across the posterior aspect of the tongue facing away from you. A cross section of the tongue will become evident with two pulsating arteries (Figure 9). Do not apply excessive pressure on the tongue or else the vessels will become compressed. You may turn on the Doppler flow to confirm the vessels are indeed arteries. Dry the dorsum of the tongue with a piece of gauze. Slide a thin metal wire (stylet from Fraser suction works well for this) between the probe and the dorsum of the tongue and visualize it as a white vertical streak on the ultrasound monitor. Move the wire so it is in line with the left artery, remove the probe from the tongue, and draw a line along the medial aspect of the wire with a marking pen. Repeat the same procedure for the right lingual artery (Figure 10).

Dab the tongue dry with a gauze sponge taking care not to smudge the markings. Use a Colorado tip monopolar cautery to divide the posterior aspect of the tongue in the midline. Be sure to stay between the arteries and aim toward the uvula (Figure 11). It is imperative that the surgeon tries to visualize the epiglottis throughout the procedure so as not to injure it. Place one suture (3-0 Prolene on RB-1 needle) on each side of the newly created incision and have your assistant retract each one anterolaterally to its respective side. Extend the midline incision more posteriorly and place two more sutures posterior to the previous sutures. Continue this process until you reach the posterior aspect of the tongue base; this usually requires four sutures to be placed on each side of the incision.

In cases where the uvula is in the way and at risk of being injured by cautery, you may retract it superiorly with a ribbon retractor (Figure 12). Although many devices can be used to remove tissue from the tongue base, the Coblator wand (EVac 70 Xtra Plasma Wand; ArthroCare ENT, Austin, TX) is easy to use and does not produce much postoperative edema or pain. Coblator settings of 7 (ablate) and 3 (coagulation) work nicely. Adequate irrigation is essential when using the Coblator, and a pressure bag for the saline may be required. Place the Coblator in a bowl of saline and let it ablate for approximately ten seconds prior to first use. The Coblator is gently rubbed back and forth from anteriorly to posteriorly until a crevice is created in the midline (Figure 13). The wand is then turned laterally to the left side of the patient's tongue to remove tissue submucosally taking care not to injury the lingual artery (Figure 14). The probe can usually be inserted the full depth of the metal Coblator shaft. The procedure is repeated on the patient's right side. A 3 mL syringe is placed in the defect and the retention sutures are crossed over each to hold the wound shut over it to ensure enough tissue has been removed (Figure 15). Ensure hemostasis has been obtained; the tongue base is difficult to access in the event of a postoperative bleed. Bleeding should be stopped immediately by pressing the Coblator wand firmly on the bleeding area and using the coagulation setting for five seconds. If this does not work after two or three attempts, you may use a suction monopolar cautery for hemostasis. In the event that a lingual artery is injured and hemostasis cannot easily be obtained, ligate the vessel with a suture. If ligation is necessary, it is wise not to be aggressive on the contralateral side because injuring both lingual arteries could result in tongue necrosis. The wound is then closed in two layers (3-0 vicryl suture on RB-1 needle) (Figure 16). The first layer closes mucosa

and muscle on one side, midline muscle deep in the newly created midline crevice (to close the dead space), and mucosa and muscle on the other side. These sutures are left long, snapped and tied at the end. The mucosa is then closed in a second layer with interrupted 3-0 vicryl sutures. The patient is extubated in the operating room. A nasal trumpet may be required.

**Postoperative Care**

This author gives clindamycin for 10 days to prevent infection from oral anaerobes. Steroids are not given following midline posterior glossectomy due to the risk of wound dehiscence. Patients are observed overnight in a closely monitored bed and are discharged when they are eating well, afebrile and their pain is controlled. This usually takes approximately four to five days. Repeat polysomnography is performed six months postoperatively. PAP ventilation may be applied if necessary as long as maximum levels of humidity are used.

**Special Considerations**

If a revision adenoidectomy is also required, the nasotracheal tube can be pushed from side to side with a dental mirror to first remove one half, and then the other half, of the adenoids. Alternatively, if this is too difficult to perform, the patient can be orally intubated (preferably prior to midline posterior glossectomy) and the adenoid removed in standard fashion. The oral ETT is then changed to a nasal ETT for the midline posterior glossectomy.

## COMPLICATIONS

Potential complications following lingual tonsillectomy and/or midline posterior glossectomy include pain, anorexia, bleeding, airway obstruction, and failure to improve or cure the OSA. Pain is managed the same as it is following TA, by keeping the mouth moist, using acetaminophen and small amounts of opiates, and rectal or intravenous pain medication where necessary. Some degree of airway obstruction (apnea and oxygen desaturation) should be expected postoperatively given that it was present preoperatively and improvement following surgery is not expected for several months thereafter. Anecdotal evidence suggests that faster improvement may be seen following removal of large lingual tonsils (rapid debulking) than following midline posterior glossectomy (requires wound contraction). A nasal trumpet with or without PAP ventilation with high humidity may be used if required. Bleeding must be dealt with expeditiously given that the site of bleeding is often difficult to reach and patients are commonly syndromic and may not be cooperative because they don't fully understand what is happening to them. OSA that does not improve following these procedures necessitates further workup in search of additional areas of obstruction.



## CONCLUSIONS

Approximately 25% of children have persistent OSA following TA and this rate is higher in children who are obese, older than seven years of age, have asthma, more severe sleep apnea, craniofacial anomalies, and chromosomal abnormalities such as Down syndrome.[1-5] Children with persistent OSA following TA who do not adhere to PAP ventilation should be investigated looking for specific anatomical areas toward which surgery should be targeted. This can be accomplished through history taking, head and

neck examination, and by using sleep endoscopy or CINE MRI. Lingual tonsillectomy and/or midline posterior glossectomy are each successful at relieving OSA in approximately 60% of patients with persistent OSA despite TA.[8,16] These procedures should therefore be part of the armamentarium of all pediatric otolaryngologists – head and neck surgeons caring for children with OSA.

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I thank the members of the DREAMS (Disorders RElating to the Airway and Mouth in Sleep) team at the Hospital for Sick Children (Indra Narang, Reshma Amin, Alison Zweerink, Igor Luginbuehl, Christian Zaarour, Susan Blaser, Albert Aziza) for contributing to the workup of these patients. I also thank Sally Shott for imparting many of the techniques described in this article.

**DISCLOSURES**

The author reports no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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## FIGURE LEGENDS

Figure 1. Patient is positioned with nasotracheal tube down left nare (white arrow) and no shoulder roll.

Figure 2. Tooth guard (white arrow) and silk suture retracting tongue anteriorly (black arrow.

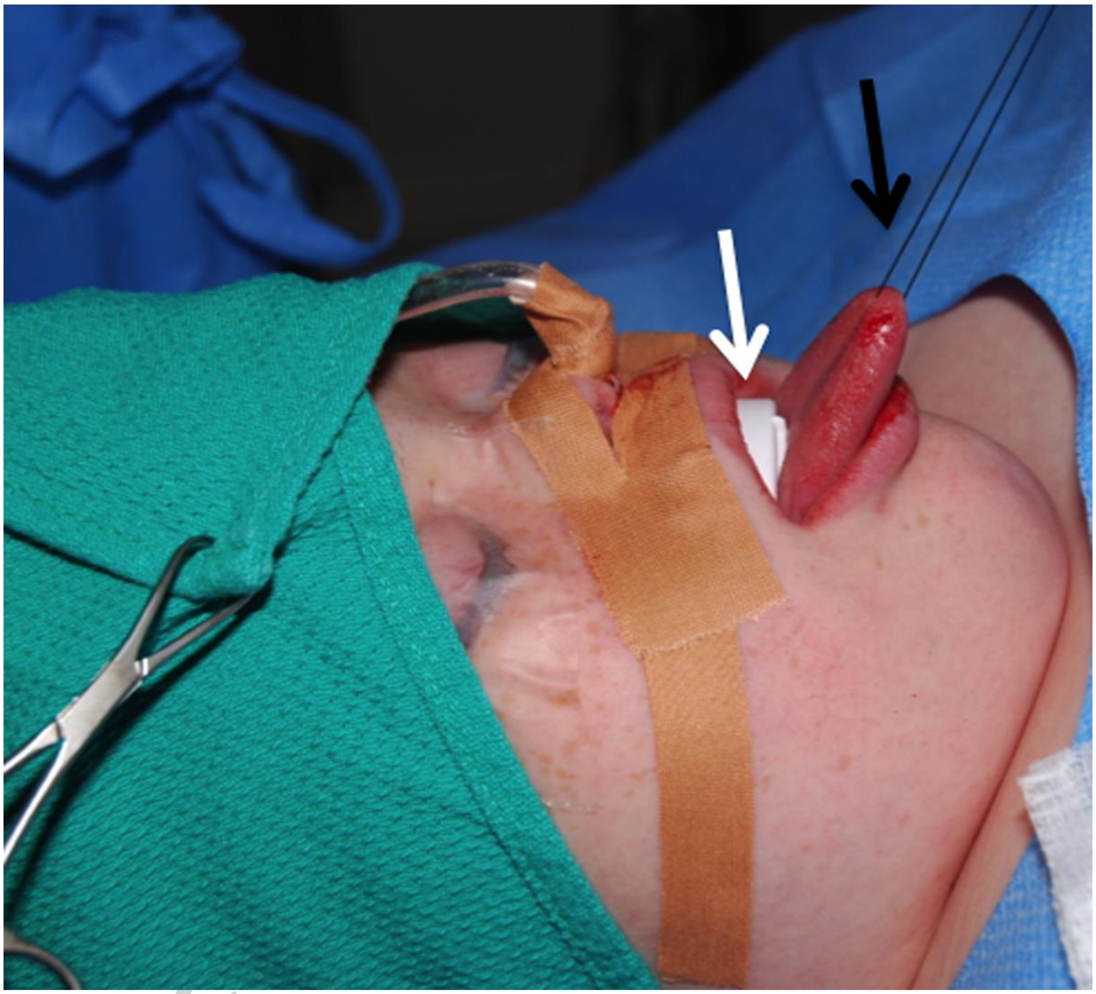

Figure 3. Insertion of Benjamin laryngoscope (white arrow). Tongue retraction suture wrapped around laryngoscope handle (black arrow).

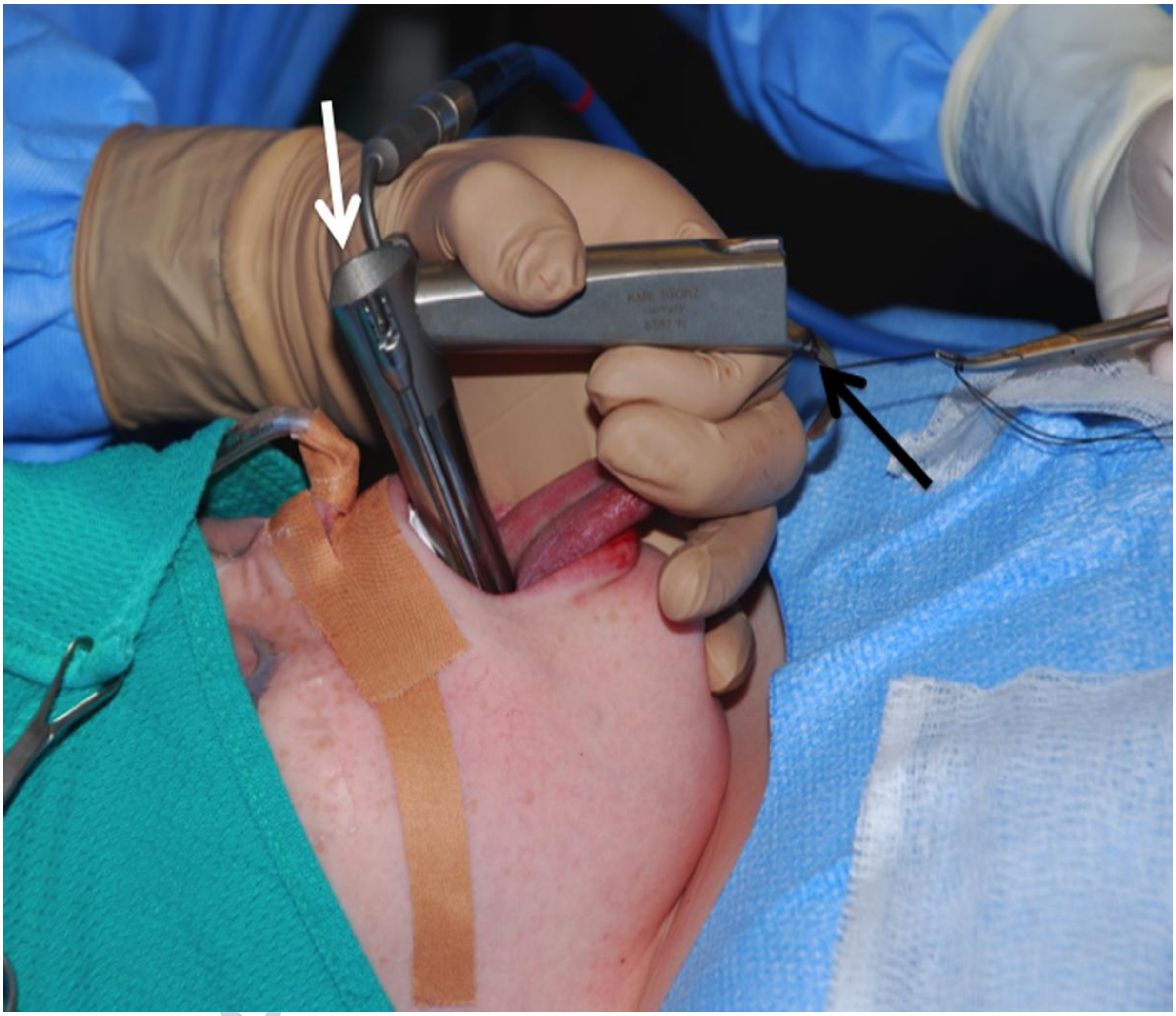

Figure 4. Fiberoptic telescope (black arrow) inserted down laryngoscope. Coblator (white arrow) placed in right side of mouth beside laryngoscope.

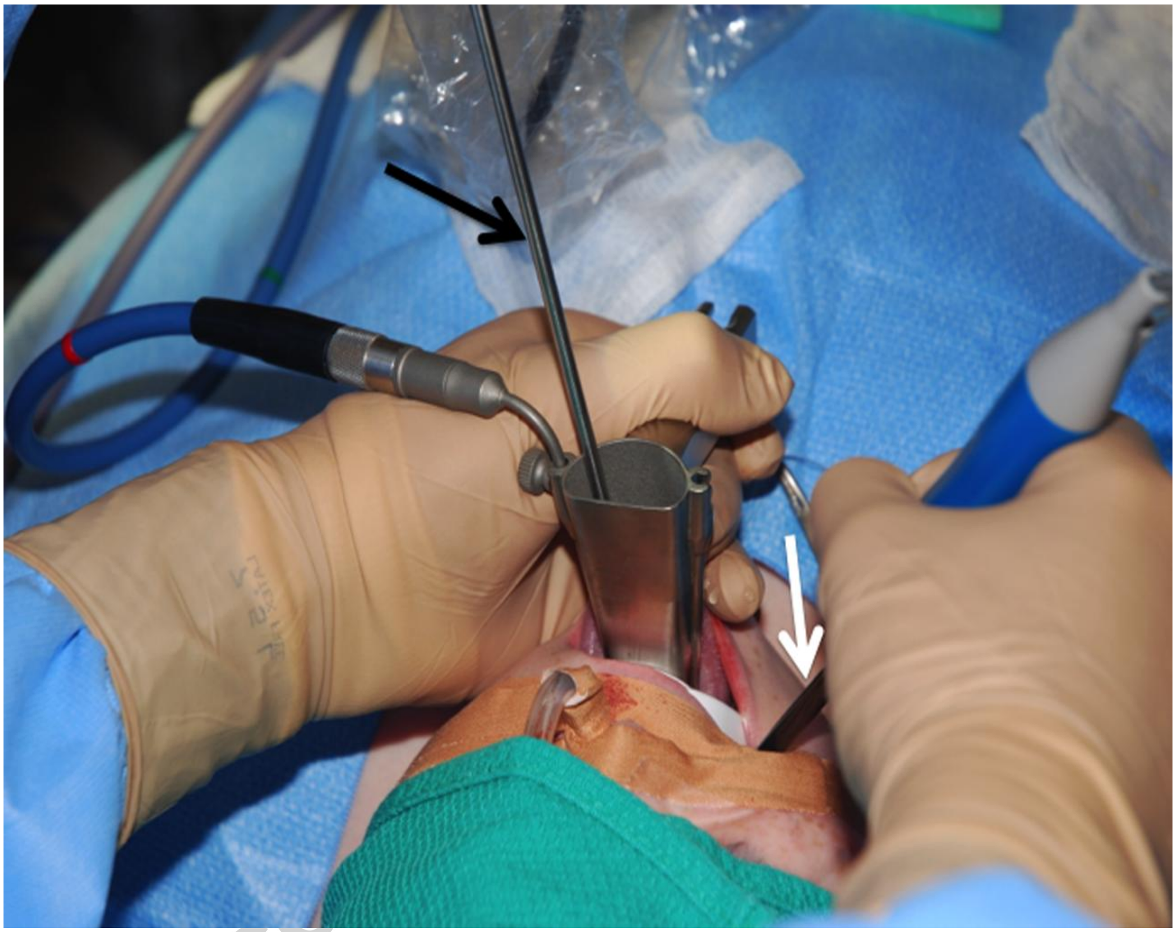

Figure 5. View down laryngoscope. A) Collapsed airway showing lingual tonsil (white arrow) in contact with uvula (black arrow). B) Airway held open with laryngoscope showing lingual tonsil (solid white arrow), tip of epiglottis (dashed white arrow), uvula (solid black arrow), and nasotracheal tube (dashed black arrow).

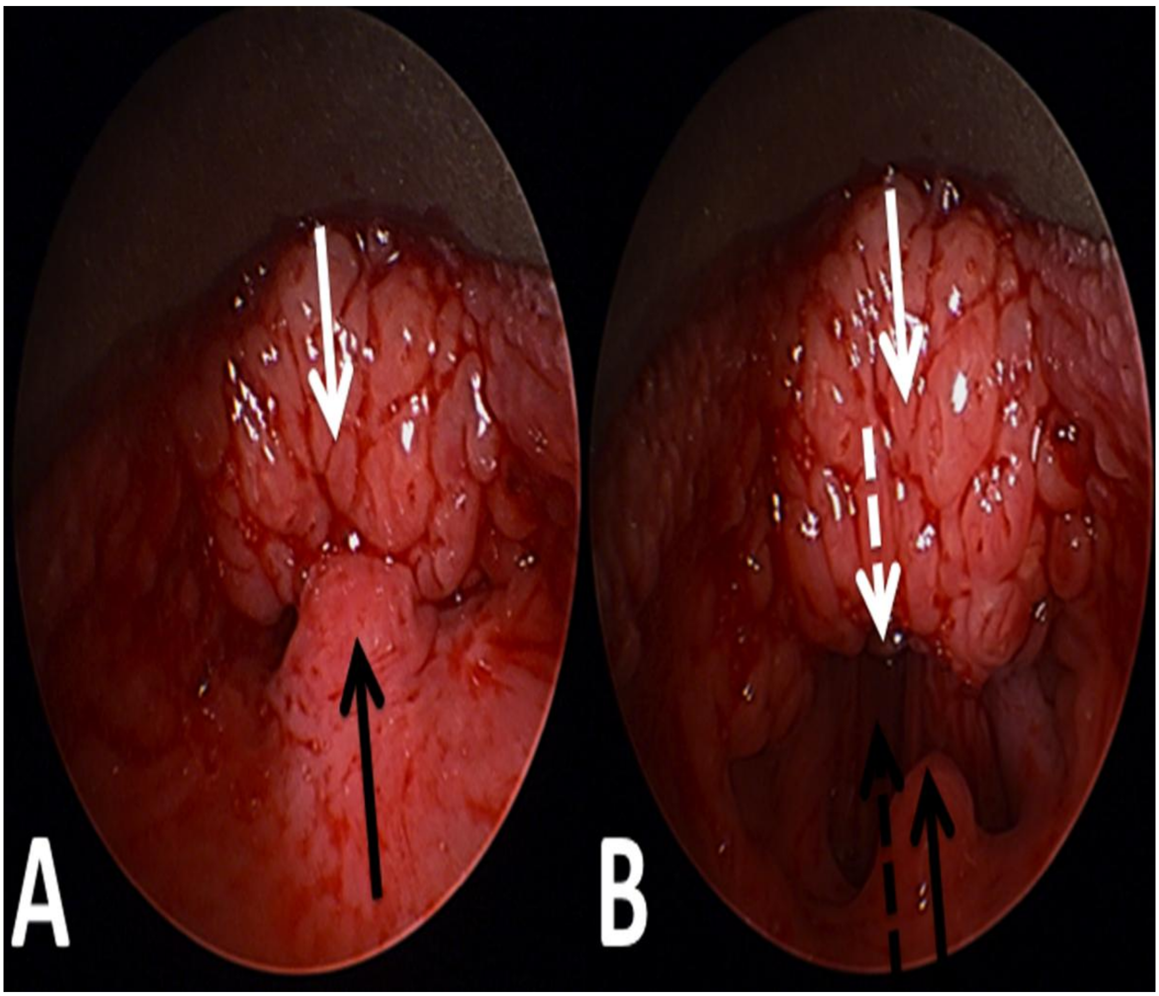

Figure 6. Tongue base following coblation of right half of lingual tonsil. Right side of tongue base without lingual tonsil (solid white arrow), epiglottis (dashed white arrow), left side of tongue base with remaining lingual tonsil (solid black arrow).

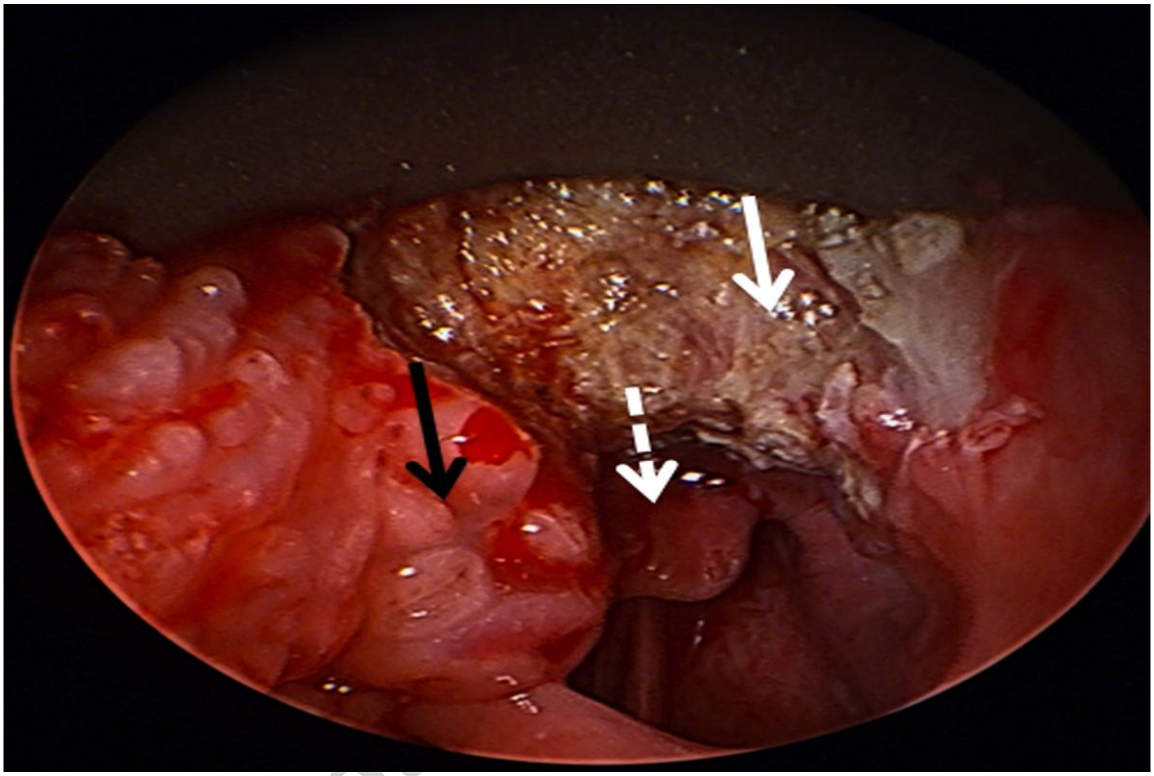

Figure 7. Exposure for midline posterior glossectomy using wedge-shaped dental bite block (white arrow) and dental cheek and lip retractor (black arrow).

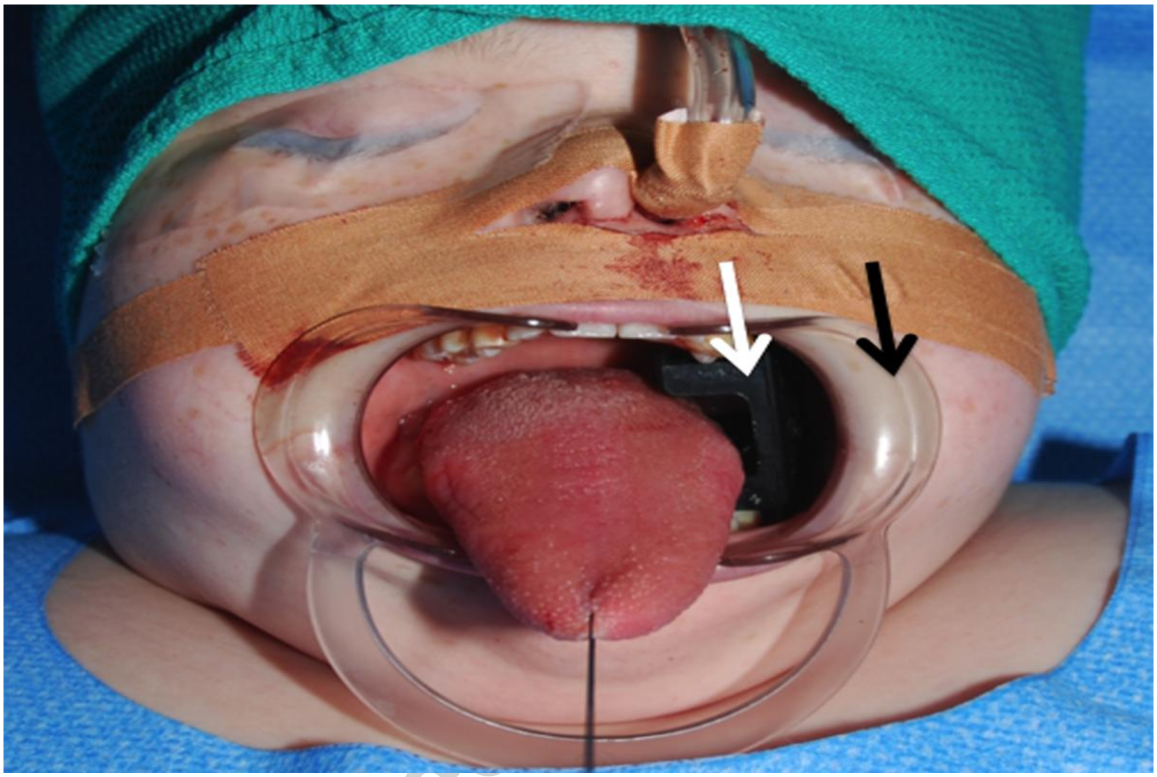

Figure 8. Using ultrasound to demarcate lingual arteries. Ultrasound probe (white arrow) is directed away from the surgeon and a thin metal wire (black arrow) is placed between the ultrasound probe and the tongue.

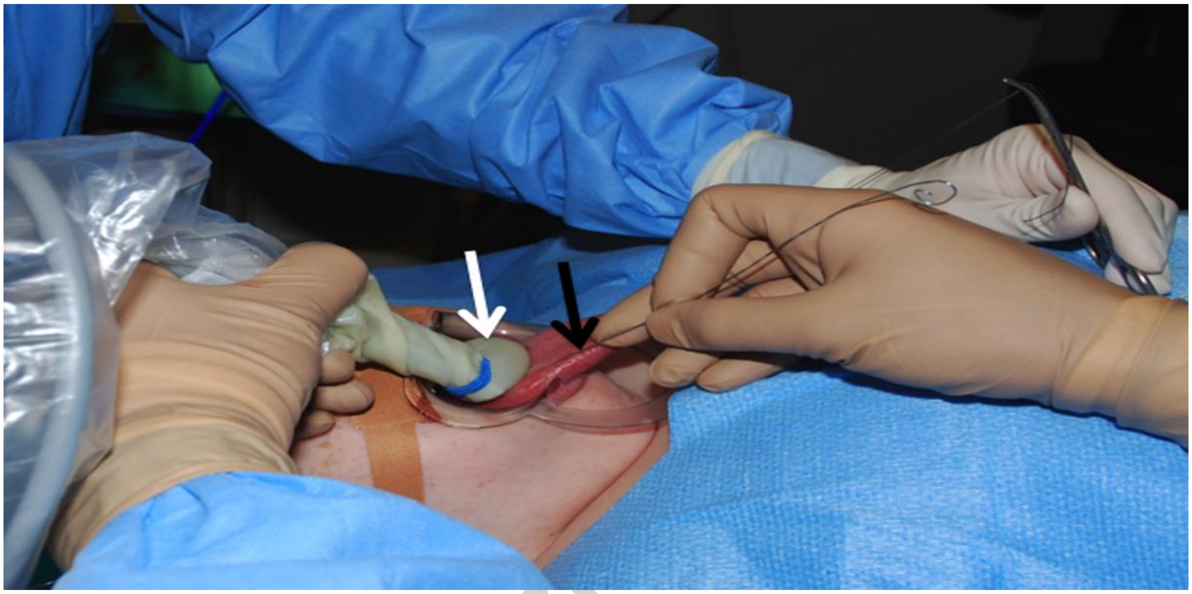

Figure 9. Ultrasound image of tongue in cross section showing lingual arteries (white arrows) and shadow of thin metal wire seen as vertical white line (black arrow).

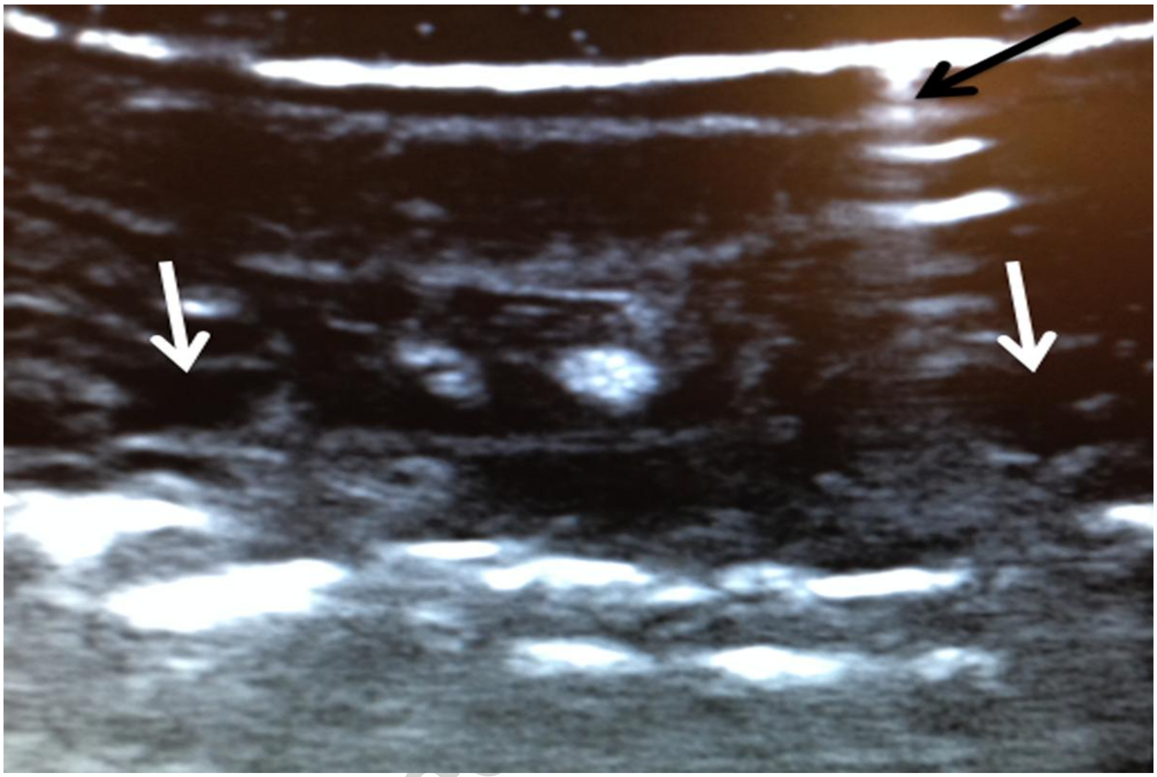

Figure 10. Lingual arteries marked on dorsum of tongue base (white arrows).

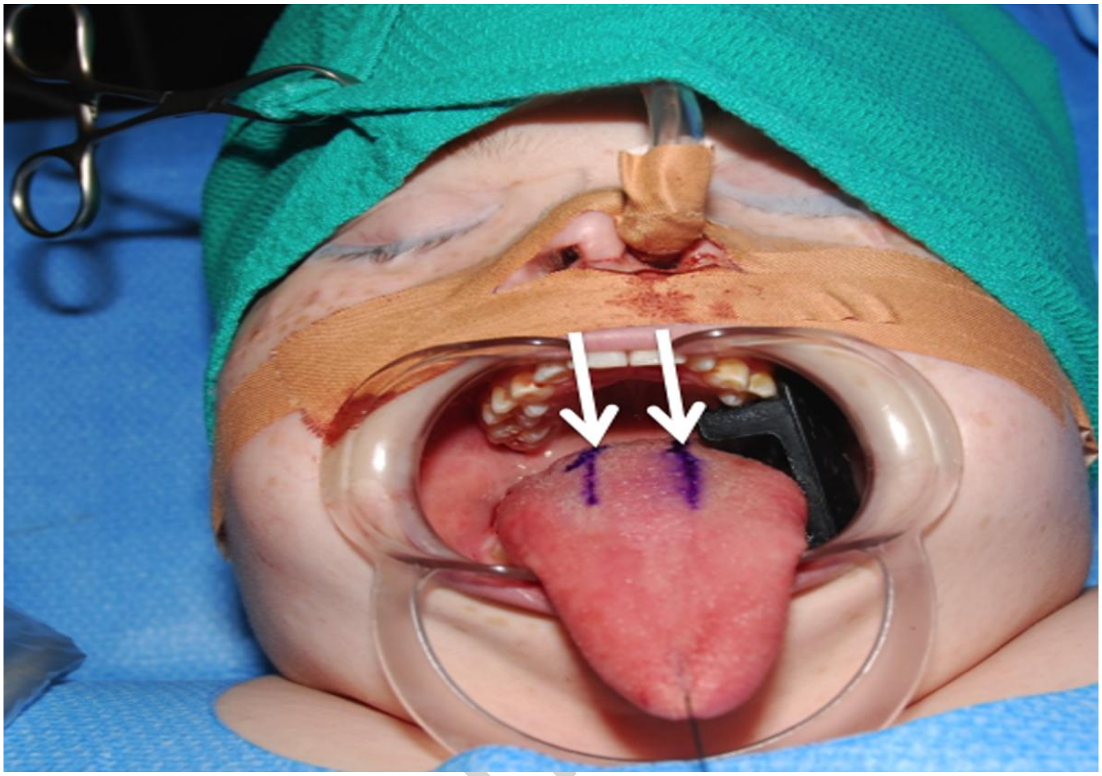

Figure 11. Tongue base divided in midline (solid white arrow) by staying between demarcated lingual arteries and aiming toward uvula (dashed white line). Sequential placement of retention sutures (black arrows) allows exposure of tongue base.

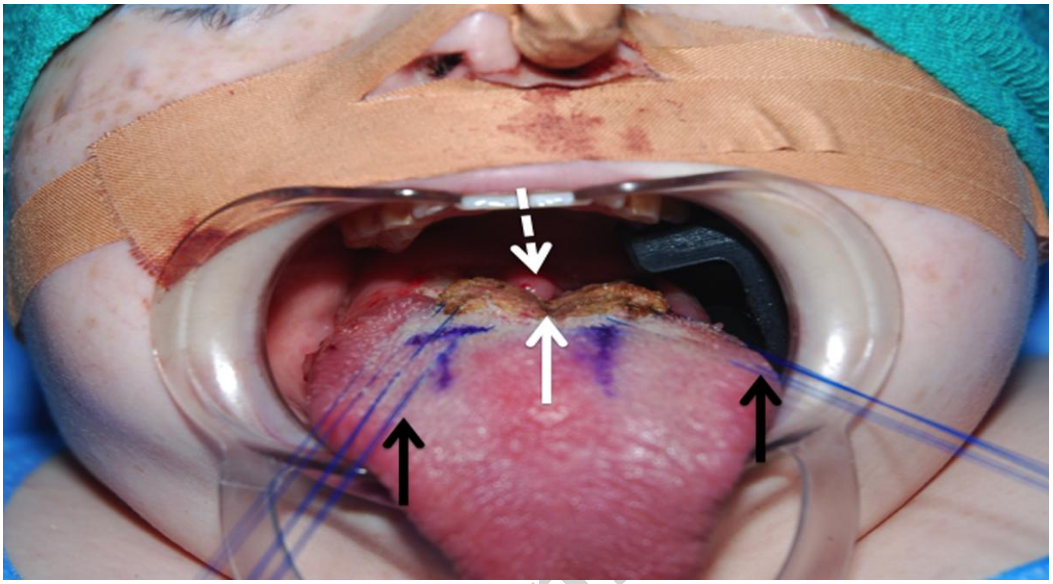

Figure 12. Magnified view of tongue base divided in midline showing epiglottis (solid white arrow) and ribbon retractor (dashed white arrow) retracting uvula to prevent injury.

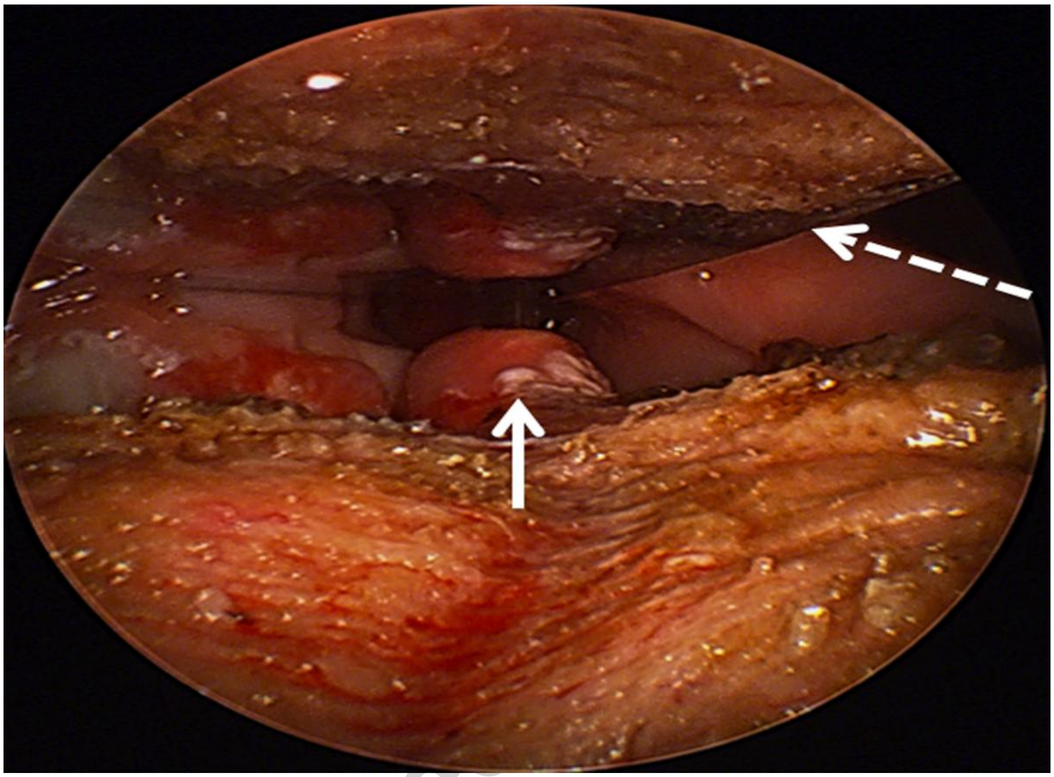

Figure 13. Metal Coblator shaft (solid white arrow) and created midline crevice (dashed white arrow).

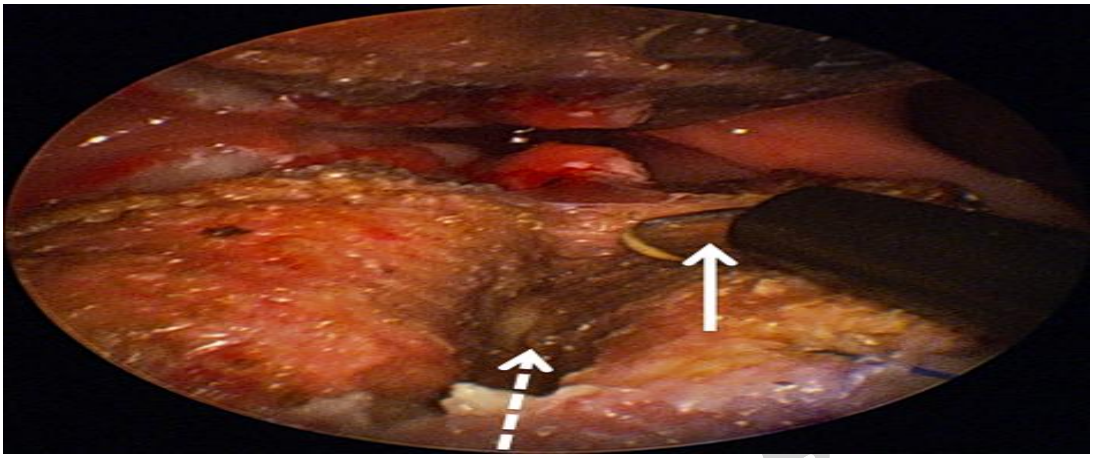

Figure 14. Lateral submucosal pockets (dashed white arrows).

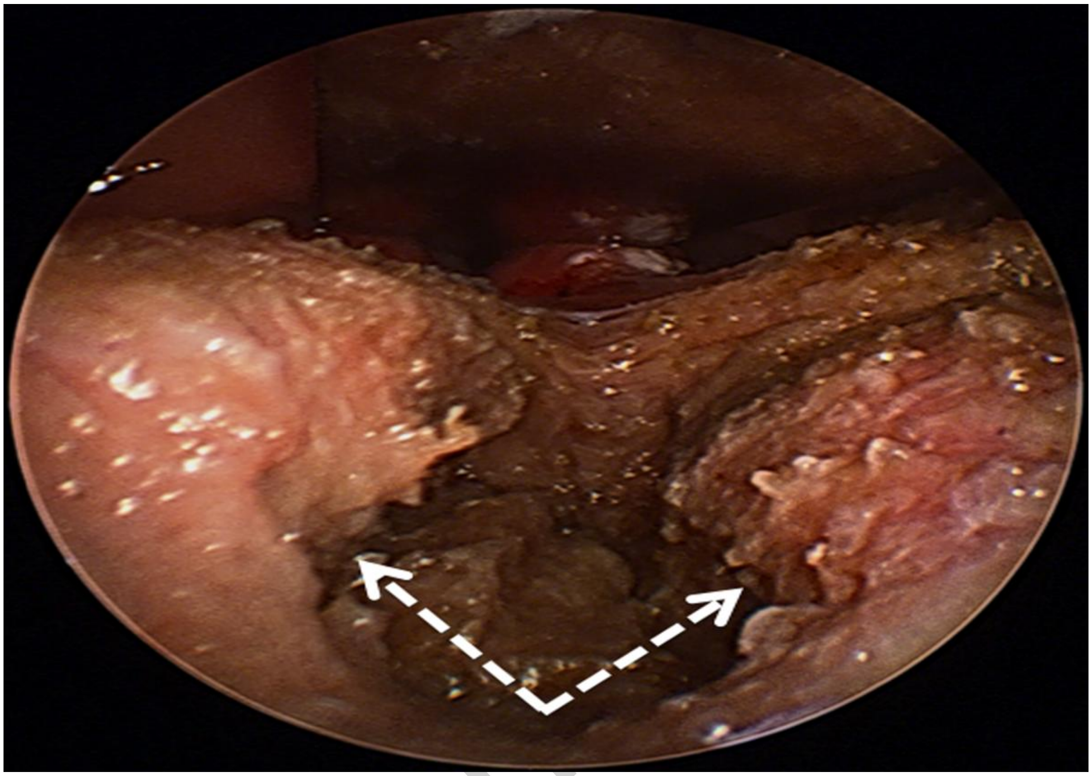

Figure 15. Syringe (3 mL) placed in created defect to ensure adequate amount of tissue has been removed.

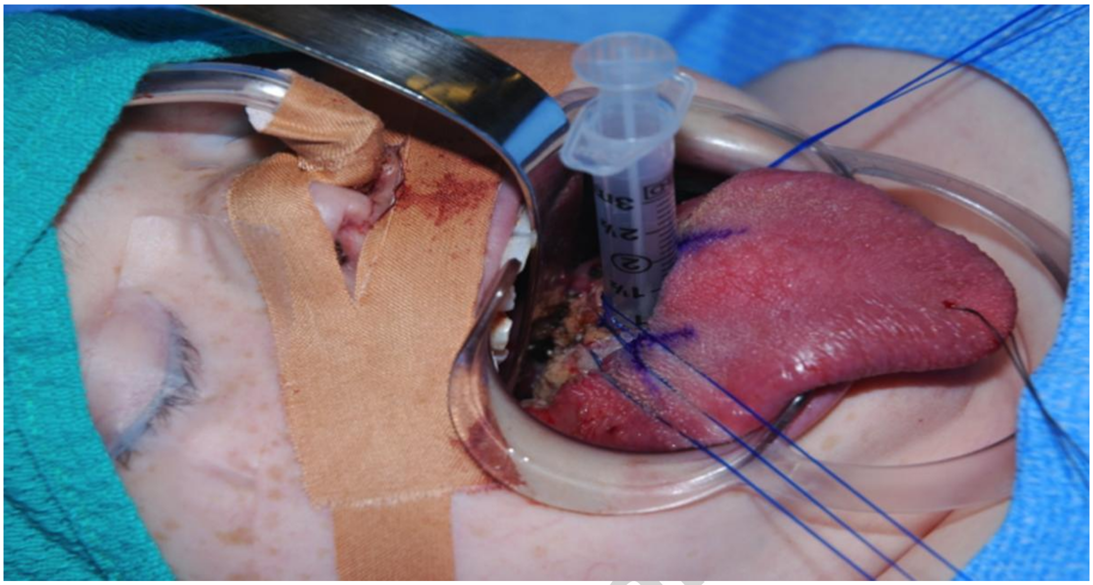

Figure 16. Tongue base following closure of defect (solid white arrow) and proximity to uvula (dashed white arrow).